

STS Safety Approval Process  
for Small Self-Contained Payloads

by

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Abstract

The purpose of this paper is to present to current and future users a description of the safety approval process established by the National Aeronautics and Space Administration (NASA) for Get Away Special (GAS) payloads. Although the designing organization is ultimately responsible for the safe operation of its payload, the Get Away Special team at Goddard Space Flight Center will act as advisors while iterative safety analyses are performed and the Safety Data Package inputs are submitted. This four phase communications process will ultimately give NASA confidence that the GAS payload is safe, and successful completion of the Phase III package and review will clear the way for flight aboard the Space Transportation System (STS) orbiter.

Introduction

All Get Away Special (GAS) payloads and canister hardware which are to be considered for space flight on the Space Transportation System (STS) must meet certain design criteria prior to flight and ground safety approval. The Goddard Space Flight Center (GSFC) Special Payloads Division is responsible for ensuring that each GAS payload assembly and its associated ground support equipment (GSE) is safe and complies with the requirements of NHB 1700.7, Safety Policy and Requirements for Payloads Using the STS, and STS Payload Ground Safety Handbook, KHB 1700.7.

Safety approval is typically divided into four steps, designated as Phases 0, I, II and III, which are reiterated as payload design is defined and gradually finalized, and as potential hazards associated with that design are identified. For most standard GAS payloads, the STS Safety Review Boards at the Johnson Space Center (JSC) and the Kennedy Space Center (KSC) become involved in the safety approval process only at the Phase III level of review; Goddard Space Flight Center is responsible for the intermediate 0, I and II levels of payload approval.

The results of each GSFC internal review and all hazard verification controls are incorporated into a final document, the Phase III Safety Data Package (SDP), and a Phase III safety review is conducted jointly with the Johnson Space Center for flight operations, and with the Kennedy Space Center for ground operations. For approval of more complicated payloads, JSC and KSC may participate much earlier in the process and would approve the payload at each level of review.

#### Payload Accomodations Requirements

The Payload Organization (PO) submits the first safety data as part of the Payload Accomodations Requirements (PAR) document. This occurs approximately twelve to fourteen months before launch, and corresponds to a Phase 0 level review. The purpose of the PAR is to identify major payload subsystems and to assess the applicability of a payload within the GAS program requirements and limitations.

Included in the PAR are a description of the payload hardware conceptual design, proposed operational requirements, and any safety related conditions or possible areas of concern. It is not important that all pertinent information be available at Phase 0, simply that a cursory look has been given and will be updated as other safety concerns become apparent throughout the process. This information is reviewed by GAS flight and ground operations personnel, GAS and JSC safety engineers, and the NASA Technical Manager (NTM), who is the single point of contact between GSFC and the PO. All comments from these participants are incorporated and finalized as a baseline PAR.

#### Phase I (Preliminary Design)

The Phase I iteration of the safety review process, submitted as a Preliminary Safety Data Package, provides more information on the safety critical components and operations of the GAS payload. A more detailed device description, hardware sketches and other preliminary illustrations should be included as part of this document. Potential payload-related hazards and proposed safety controls and inhibits should be discussed, and a hazard control verification plan developed for evaluation. Hazard reports for each identified hazard should also be submitted with the Preliminary Safety Data Package.

Hazards are categorized as either critical or catastrophic. A critical hazard is defined as anything that could cause unintentional damage to the orbiter, proximity payloads or the GAS container itself. Critical hazards must be controlled to one failure tolerance, meaning the payload must remain safe even after one credible component failure. Those hazards which could result in personnel injury, loss of the orbiter, or destruction of STS and other equipment are considered catastrophic, and must be shown to be two failure tolerant. The data provided by the PO must substantiate the above when addressing each potential hazard.

The Preliminary Safety Data Package is distributed to members of the GAS team for independent review. A joint review is then held with the NASA Technical Manager and GAS safety and operations personnel to discuss questions or areas of concern regarding the information provided. Pertinent GSFC technical experts are also available for consultation if necessary. The Payload Safety Officer (PLSO) incorporates all comments from this review into one marked-up version of the safety package, which is sent to the Payload Manager along with a letter of clarification of those comments.

Several weeks after the SDP is returned to the Payload Organization, a telephone conference is scheduled by the NTM and Payload Manager to discuss any questions the PO may have concerning the GSFC Phase I review. This discussion is typically focused on the incorporation of additional information in preparation of the Final Safety Data Package required for Phase II of the review process.

#### Phase II (Final Design)

At Phase II, fairly detailed hardware illustrations, system or subsystem block diagrams, and detailed schematics showing the necessary hazard controls are required. As payload design proceeds, more detail is needed on hazards that could affect STS flight and ground operations and crew. Payload descriptions must begin to include specific information about payload subsystems, potential hazards and proposed controls, and methods of verifying hazard controls.

During this period, the payload organization must begin to submit a reviewable summary of each hazard verification method. This information would include, for

example, structural and other analyses, a parts and materials list of all payload components, and results of such things as vibration testing, leak and proof pressure testing of sealed containers, and functional testing of fuses, temperature and low voltage cutoffs, and other battery or circuitry malfunction controls. These summaries are reviewed, independent of the payload organization, to ensure that the data contained therein is complete and accurate, and successfully meets the requirements for controlling hazardous functions or subsystems. Copies are kept on file with GAS safety engineers for future reference if necessary.

As before, GAS safety engineers independently review the system inputs, recommend changes or additions to the identified hazards, and review and approve the safety verification of these hazards. The PLSO incorporates this data into a marked-up copy of the Final Safety Data Package which is again sent to the Payload Manager via the NTM. Another telephone conference is scheduled to clarify any questions about the Phase II review and discuss additional information needed to prepare the Phase III Safety Data Package, including completed hazard reports, for submittal to the JSC and KSC Safety Review Boards.

### GSFC Phase III

The Phase III Safety Data Package is the final submittal of safety information. It states that adequate analysis and testing of the GAS payload has been performed and identifies all hazards that could be associated with the operation or malfunction of the payload or payload component. The Phase III package must include a detailed discussion of appropriate safety measures which have been implemented to effectively eliminate or control these hazards.

Each hazard report is considered a stand-alone document at the Phase III level. All credible failure modes of a payload must be identified by this point, and the hazard potential of each specific failure must be assessed. Hazard controls and methods of verifying that those controls are in place and operational are established to ensure that all unsafe conditions are inhibited to an acceptable level of safety risk, i.e. one or two failure tolerant. Verification methods may include tests, analyses or inspection, and similarity to other payload designs may sometimes be used if approved by the GAS and STS Safety Review Boards.

The status of each verification method must be tracked as payload design proceeds. An item is considered to be "open" until a test or analysis is complete and the results have been submitted and approved by GSFC. In general, all verification methods must have a "closed" status before Phase III safety approval will be given. Along with a "closed" status, supportive data for each method of hazard control verification must be included for future reference or auditing. This data would include, but is not limited to, test and analysis report numbers, inspection procedure numbers, quality control log book references, drawing numbers and completion dates.

In some cases, the Phase III Safety Data Package may be submitted to the STS with "open" status items. For example, procedures which are to be performed as part of final payload preparation at KSC would remain "open" until payload close-out. However, a copy of the procedure must be on file with GAS personnel, and reference to the specific procedure number as part of the hazard report is required.

### STS Phase III

Upon GSFC Phase III approval, the Phase III Safety Data Package is submitted by the GAS project to both the KSC and JSC for review. Included with this submittal are a signed Certificate of STS Payload Safety Compliance signed by the GAS Project Manager, and a letter of approval from the GSFC Materials Control and Applications Branch for all parts and materials used on the payload.

KSC reviews are focused on potentially hazardous ground payload processing operations such as battery top-off charging and hoisting, and the use of other ground support equipment and tools brought to KSC by the payload organization. The JSC safety board reviews payload flight operations for compatibility with manned-flight requirements and regulations, and ultimately determines that a payload is safe for flight aboard the STS orbiter.

These reviews are typically handled administratively between NASA centers, however in some cases a formal review may be required. If so, the appropriate GAS safety personnel would meet with STS safety personnel to clarify any outstanding issues and generate an acceptable, approved Phase III Safety Data Package.

As part of updated post-Challenger documentation requirements, those GAS payloads which had previously been approved through STS Phase III prior to January 1988 are now required to submit a Delta Phase III Safety Data Package. The purpose of this additional step in the approval process is to ensure the STS safety boards that the payload has been reevaluated and remains in compliance with NASA safety standards and regulations. Prior to STS resubmittal, new signatures of approval are required from the GAS Project Manager, GAS Safety Engineer and the GSFC Materials Control and Applications Branch for reexamined parts and materials usage.

#### Post Approval

Receipt of STS flight and ground safety approval is the final step in the review process. The GAS payload is then appropriately inserted into the GAS manifesting queue to await a flight opportunity. Once manifested, the Payload Organization delivers the payload to KSC, where final preflight inspection is performed by the GSFC. In some cases, a verification or demonstration of the hazard controls referenced in the safety documentation may be requested. This inspection verifies that the payload is exactly as described in the safety information previously provided, and is indeed safe for STS flight.

#### Conclusion

The four phase safety review and verification process established for small, self-contained payloads, and specifically Get Away Special payloads, is an important process which ultimately gives NASA confidence that a GAS payload assembly is safe and is in compliance with STS safety regulations as defined in NHB 1700.7 and KHB 1700.7. The requirements set forth by NASA in those documents are intended to protect flight and ground personnel, the STS, other payloads and associated ground support equipment and the environment from payload-related hazards.

The information provided in the Safety Data Packages should become more specific and complete with each successive step in the approval process. For each phase of review, the Get Away Special team at Goddard Space Flight Center will act as advisors while iterative safety analyses are performed and these Safety Data Package inputs are submitted. Several iterations help to ensure that all potential hazards associated with a GAS payload have either been eliminated by design, or are controlled to an acceptable level of risk.

By establishing regular safety communications early in the system development, the payload organization will benefit from GSFC and STS safety engineering experience, and therefore possibly avoid costly or time consuming design errors; cooperation throughout this communications effort will result in a GAS payload design which is considered safe and flight ready. Upon successful completion of the Phase III Safety Data Package and review, the GAS payload will be appropriately inserted into the GAS manifesting queue, and will ultimately be awarded a flight opportunity aboard the STS orbiter.

#### References

- 1) NHB 1700.7 "Safety Policy and Requirements for Payloads Using the Space Transportation System"
- 2) KHB 1700.7 "STS Payload Ground Safety Handbook"
- 3) JSC 13830 "Implementation Procedure for STS Payloads System Safety Requirements"
- 4) "Get Away Special Payloads Safety Manual", May 1986

